

Estimation of Spatial and Temporal Changes in Land Surface Emissivity to Improve Modeling of Evapotranspiration

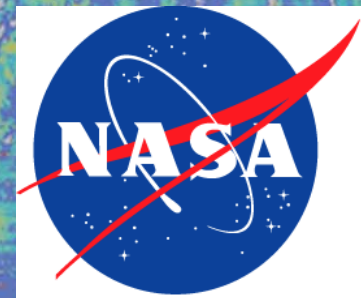
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Emissivity Heterogeneity over the Southwestern USA

Jornada

Gulf of California

$$R_n - G = H + LE$$

Kelvins

GOES Band 4

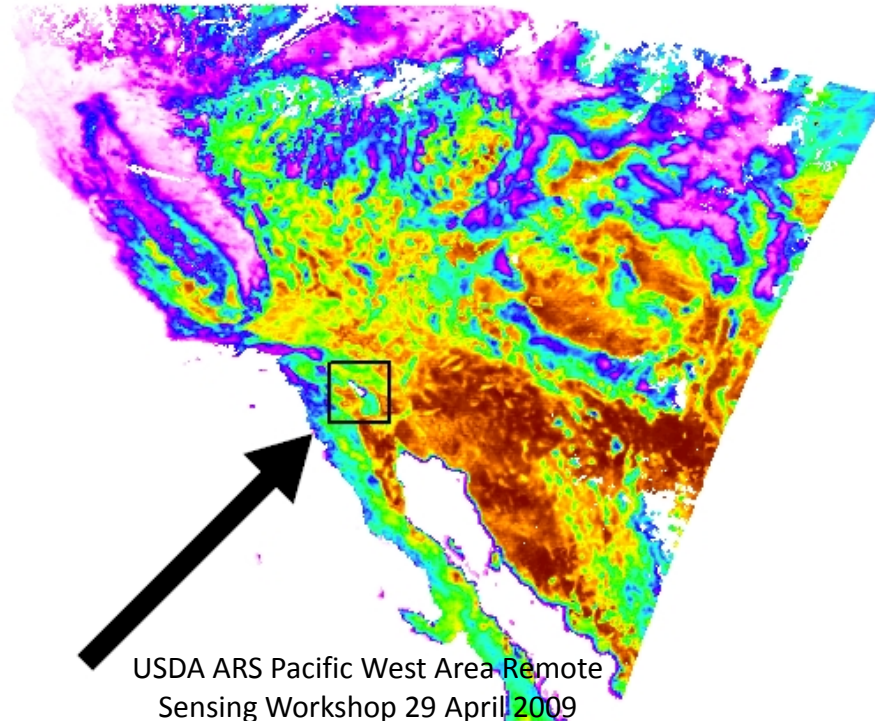
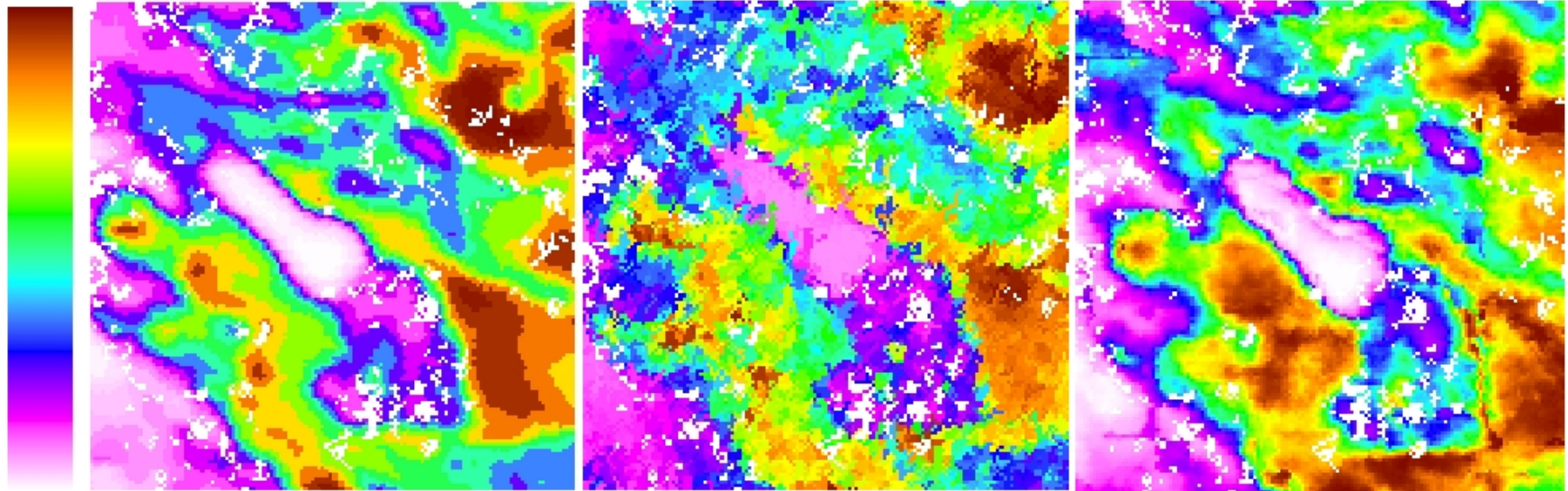
MODIS LST

Merged LST

325

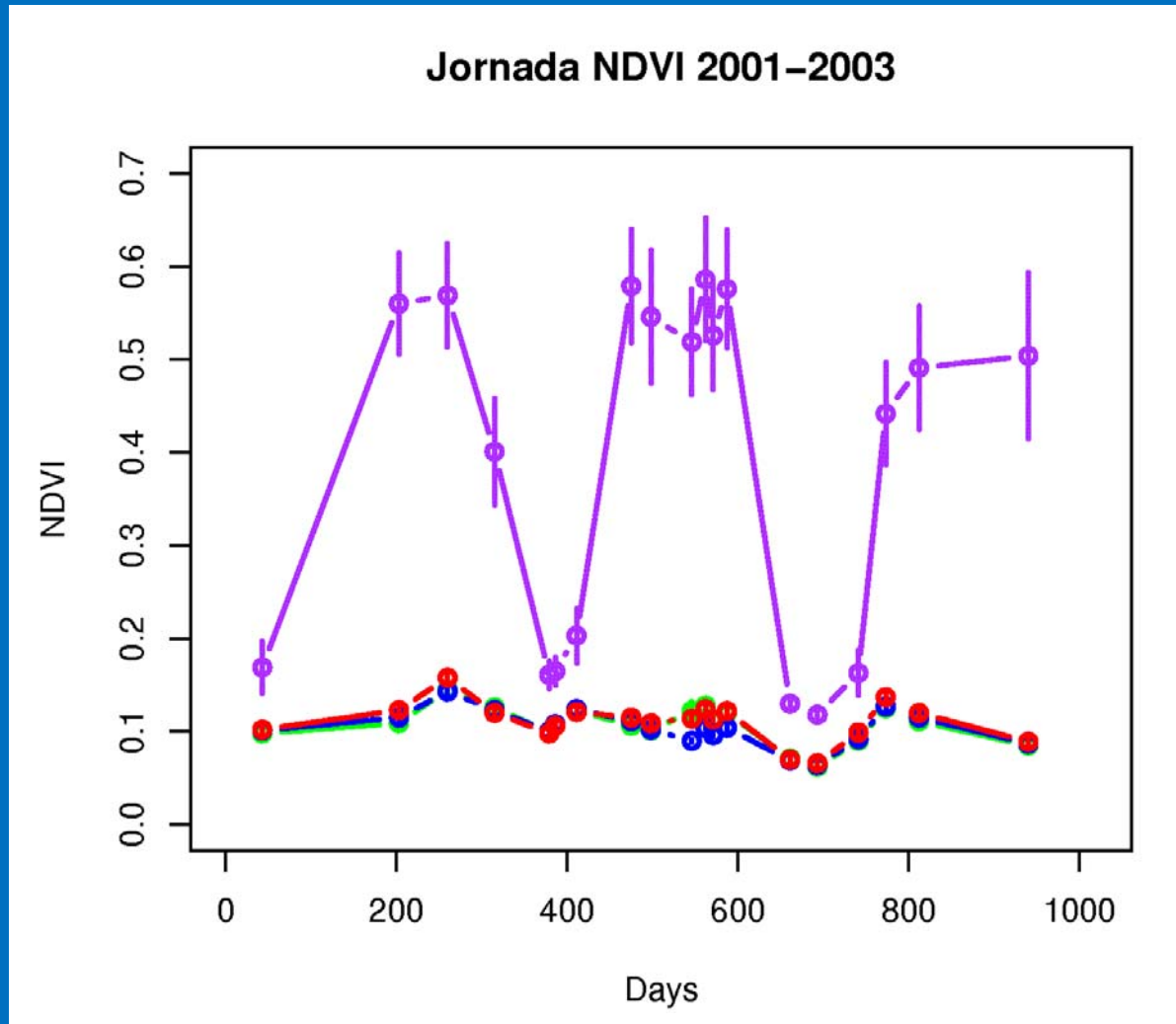
310

295

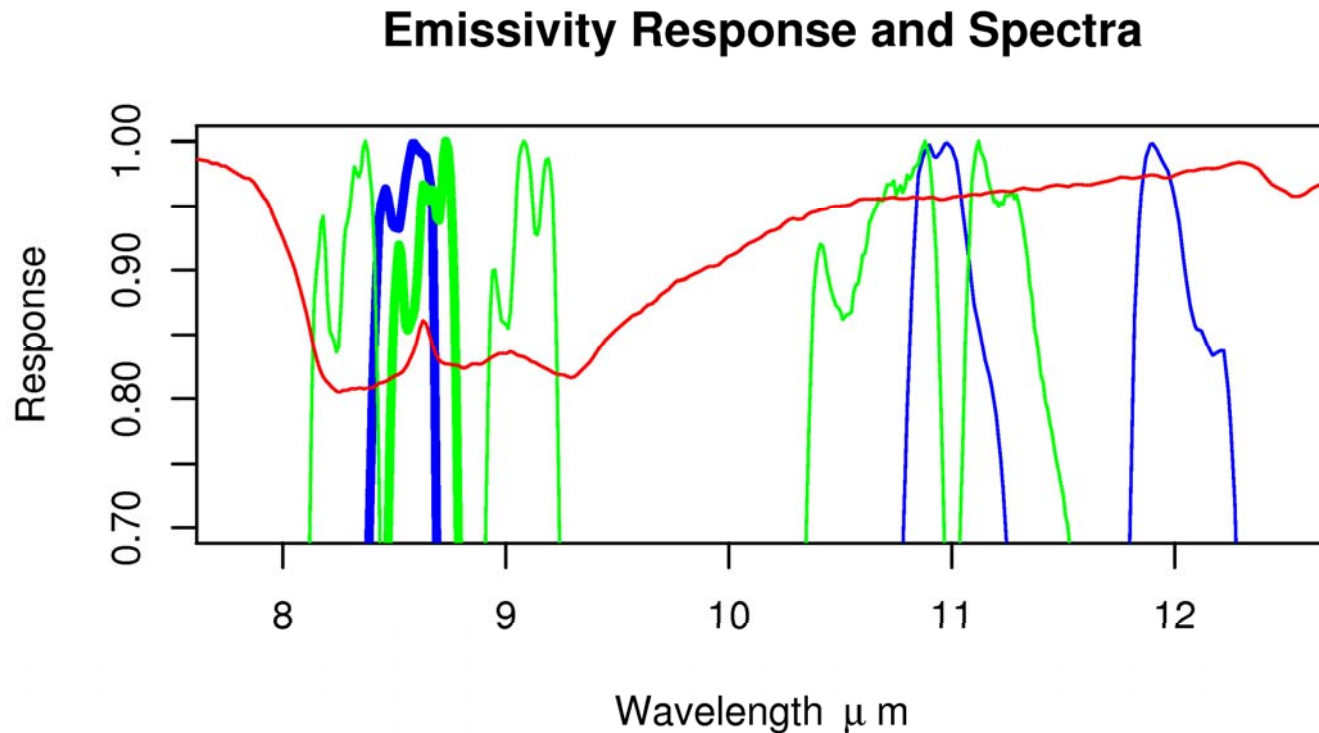


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NDVI for Jornada & Rio Grande 2001-2003



ASTER & MODIS Thermal Band Responses



Effect of Emissivity on Land Surface Temperature

Errors in estimated emissivity can result in LST retrieval errors of 2-3 C

Depending upon resistance term, these errors can exceed 50 W/m²

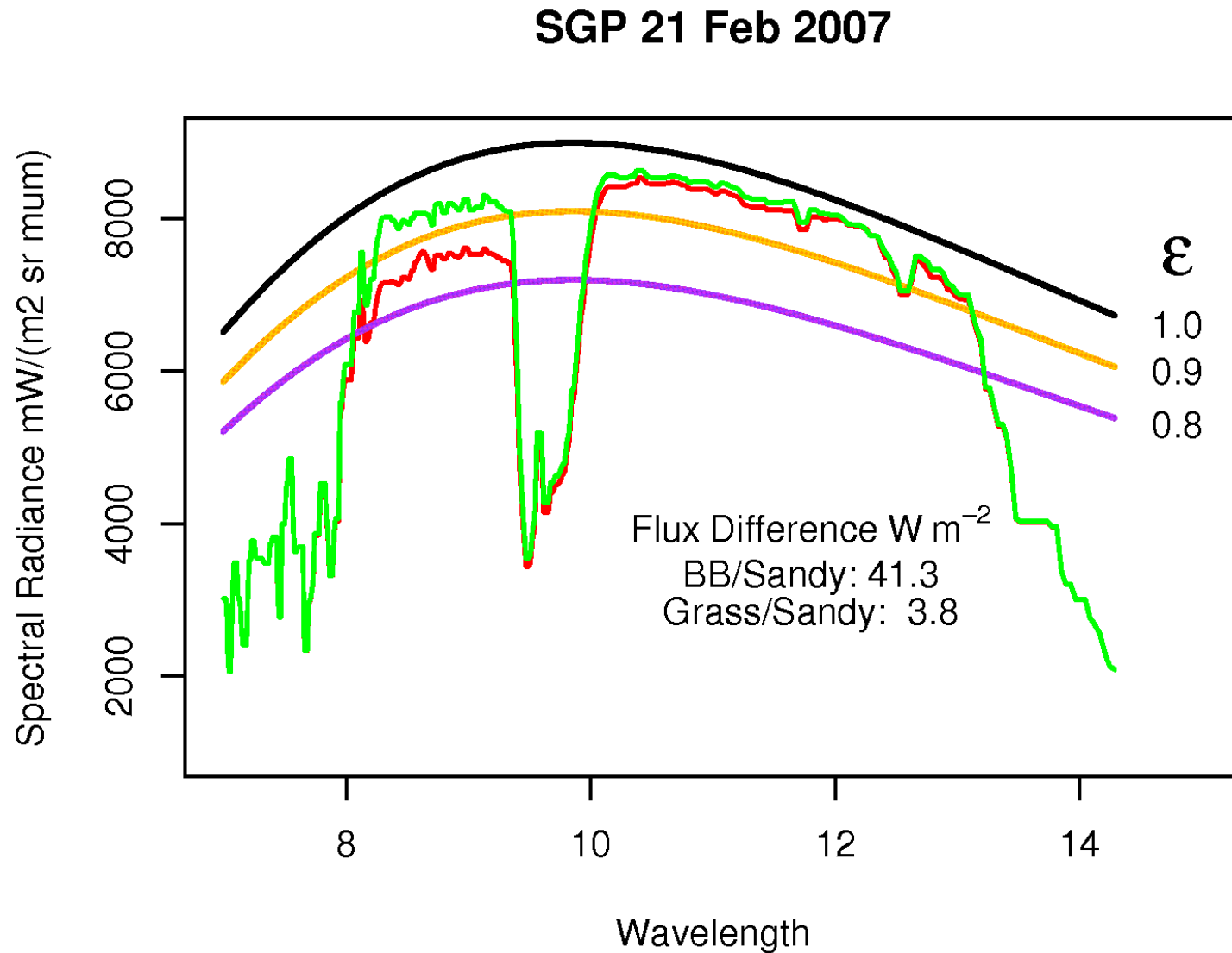
$$H = \rho c_p \frac{\Delta T}{r_a}$$

Effect of Emissivity upon Land Cover Classification

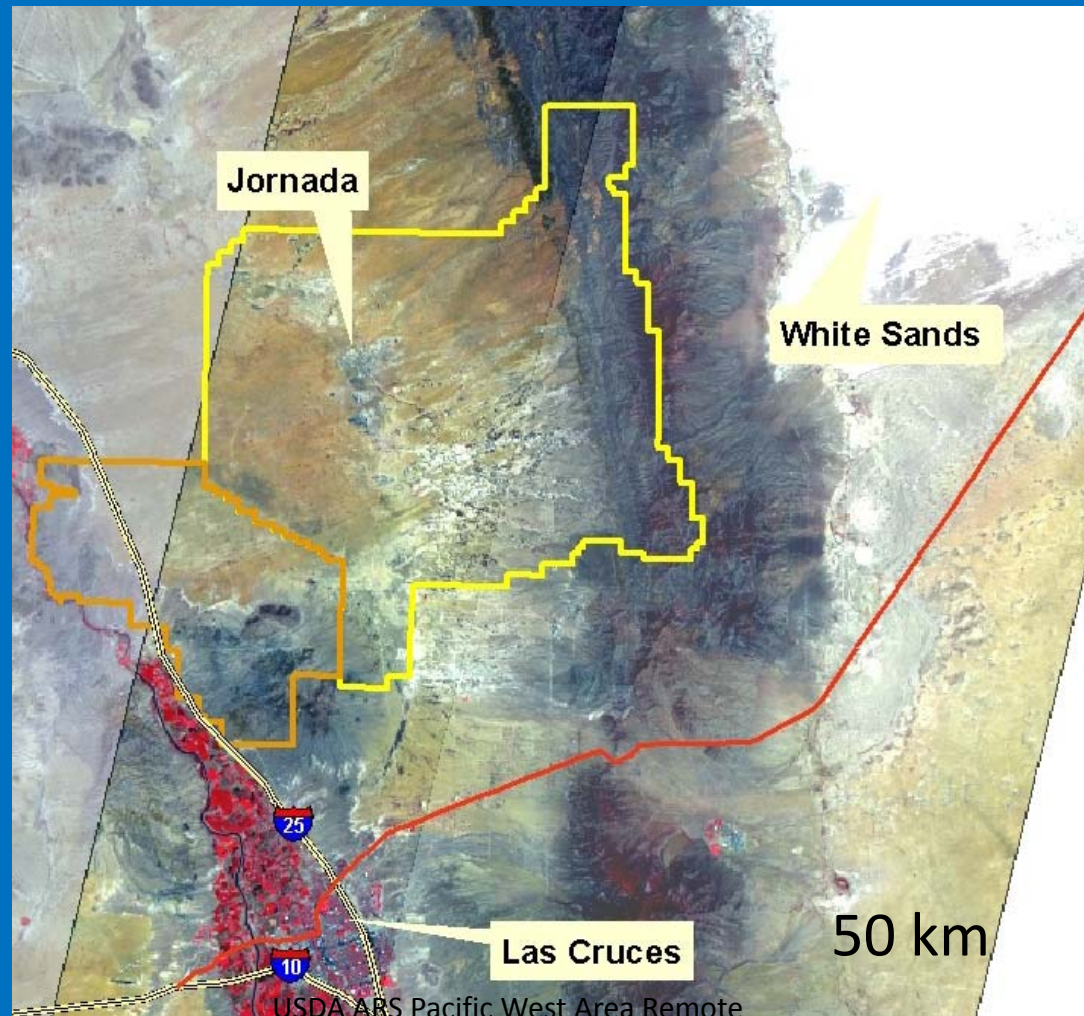
Can determine estimation of surface resistance

- Distinguish between bare soil and senescent vegetation
- Better estimation of canopy geometry & canopy height $z_M = h/8$
- Improve estimation of r_a and r_s

Effect of Emissivity on Net Longwave Flux

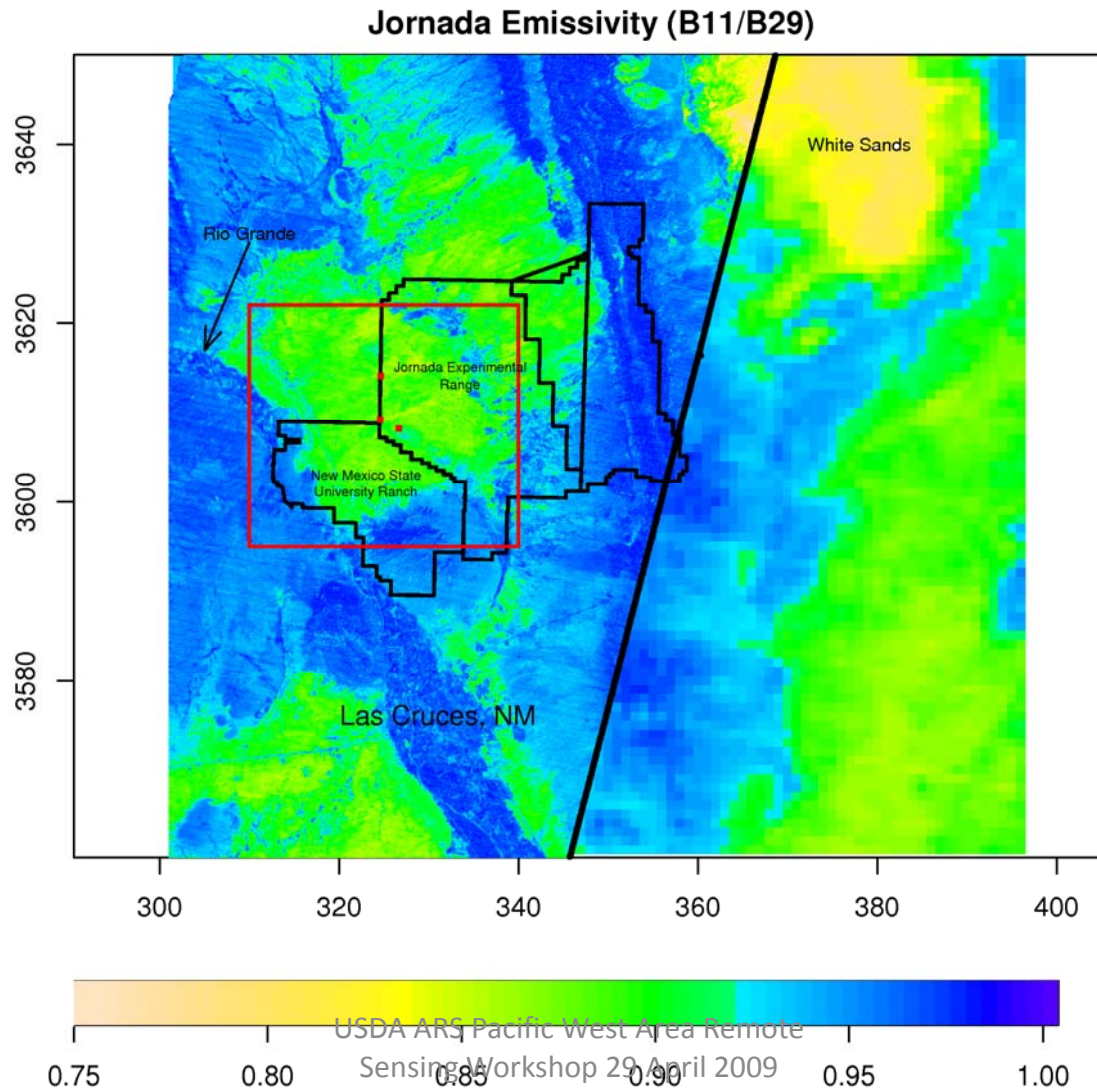


ASTER Composite over Jornada 2001-2003

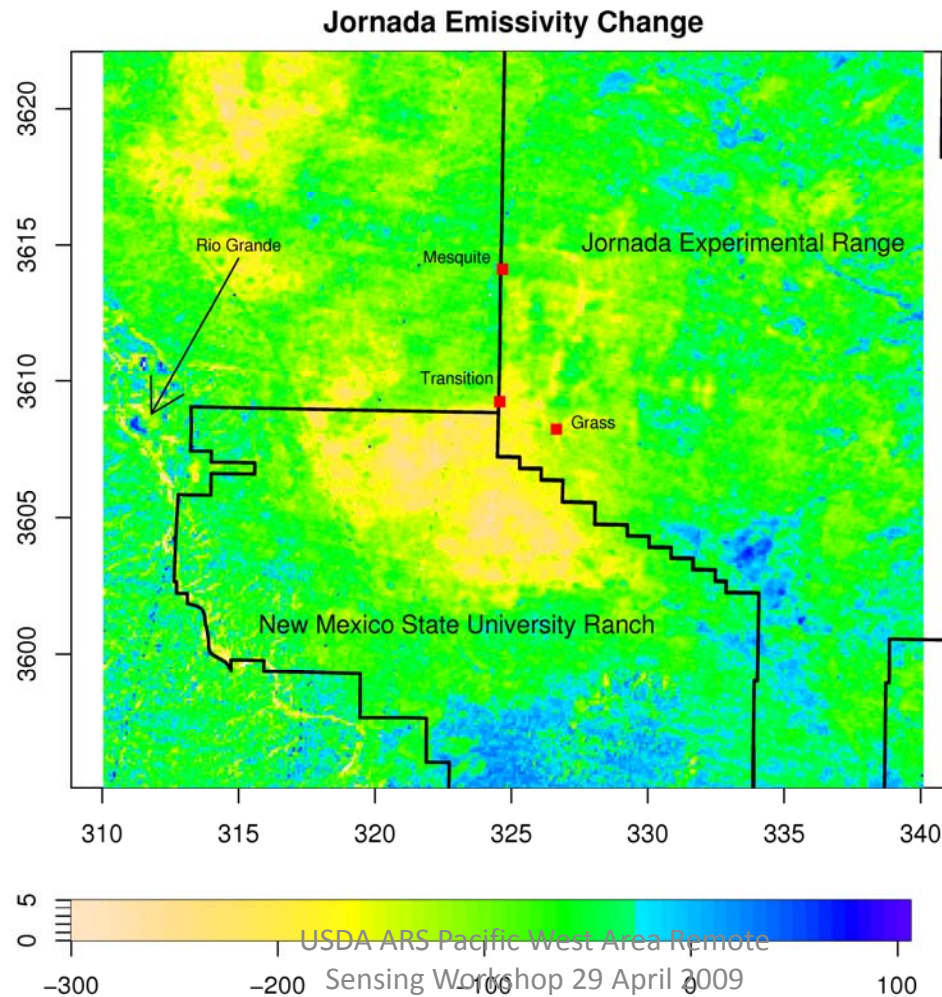


Short Wavelength TIR with ASTER/MODIS

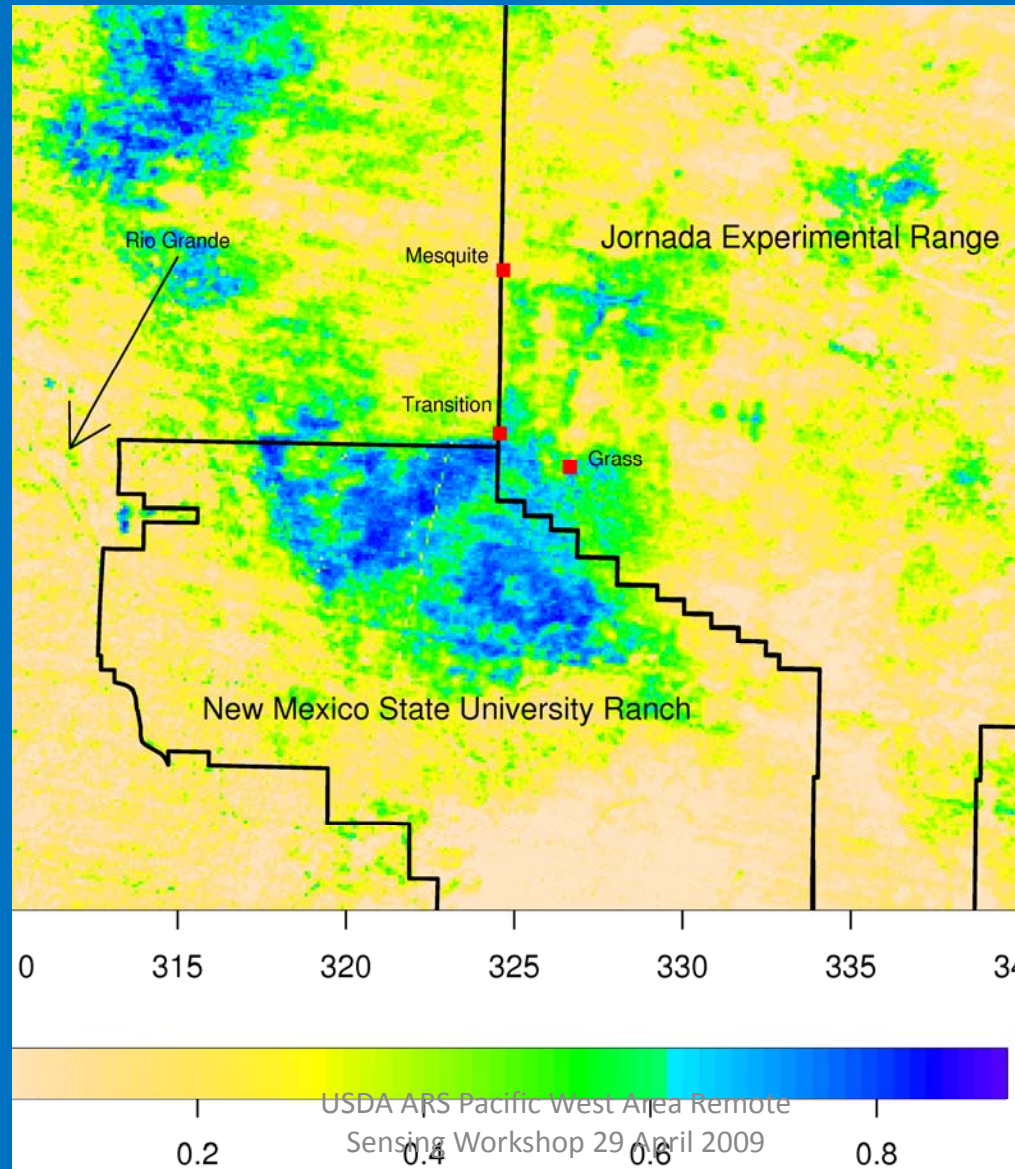
Jornada 2003



Linear Broadband Emissivity Trend 21 ASTER scenes, 2001-2003 Small Changes: < 1%/year

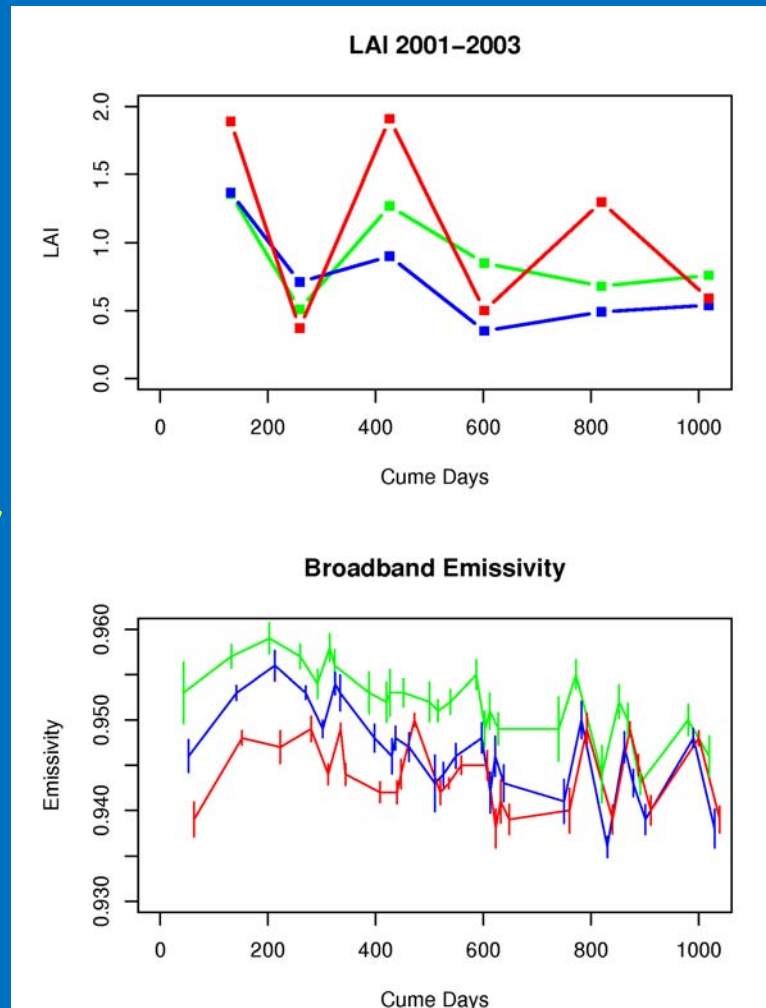


Coefficient of Determination (R^2): 0.55 to 0.85



Change Verification: LAI & Emissivity 2001-2003

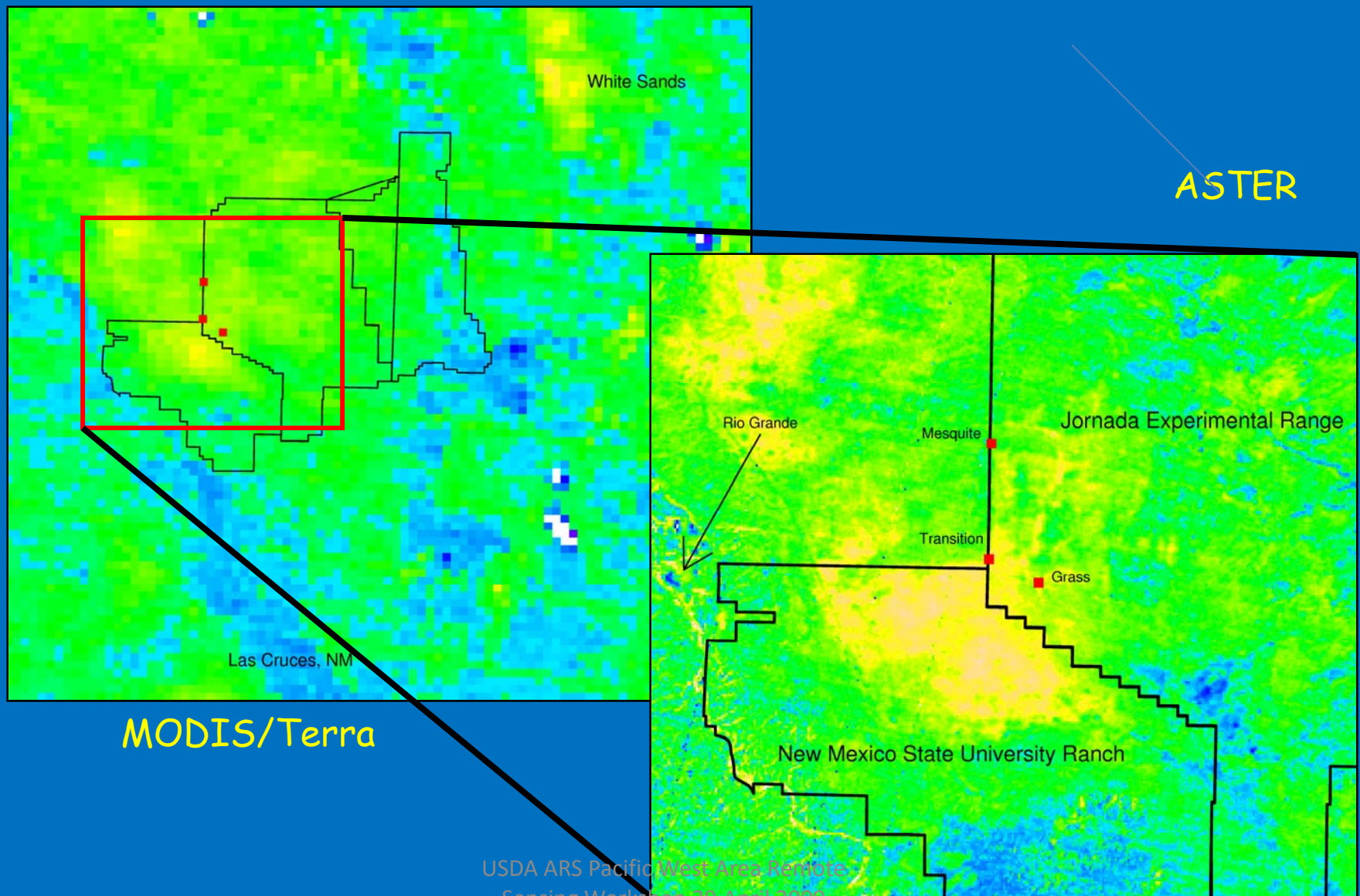
Qualitative support for trend
Sites are not in trend core
Decrease from 0.955 to 0.945,
then flat or recovery



LAI

Emissivity

Emissivity Changes Observed by ASTER & MODIS



Explanations for Observed Emissivity Trends

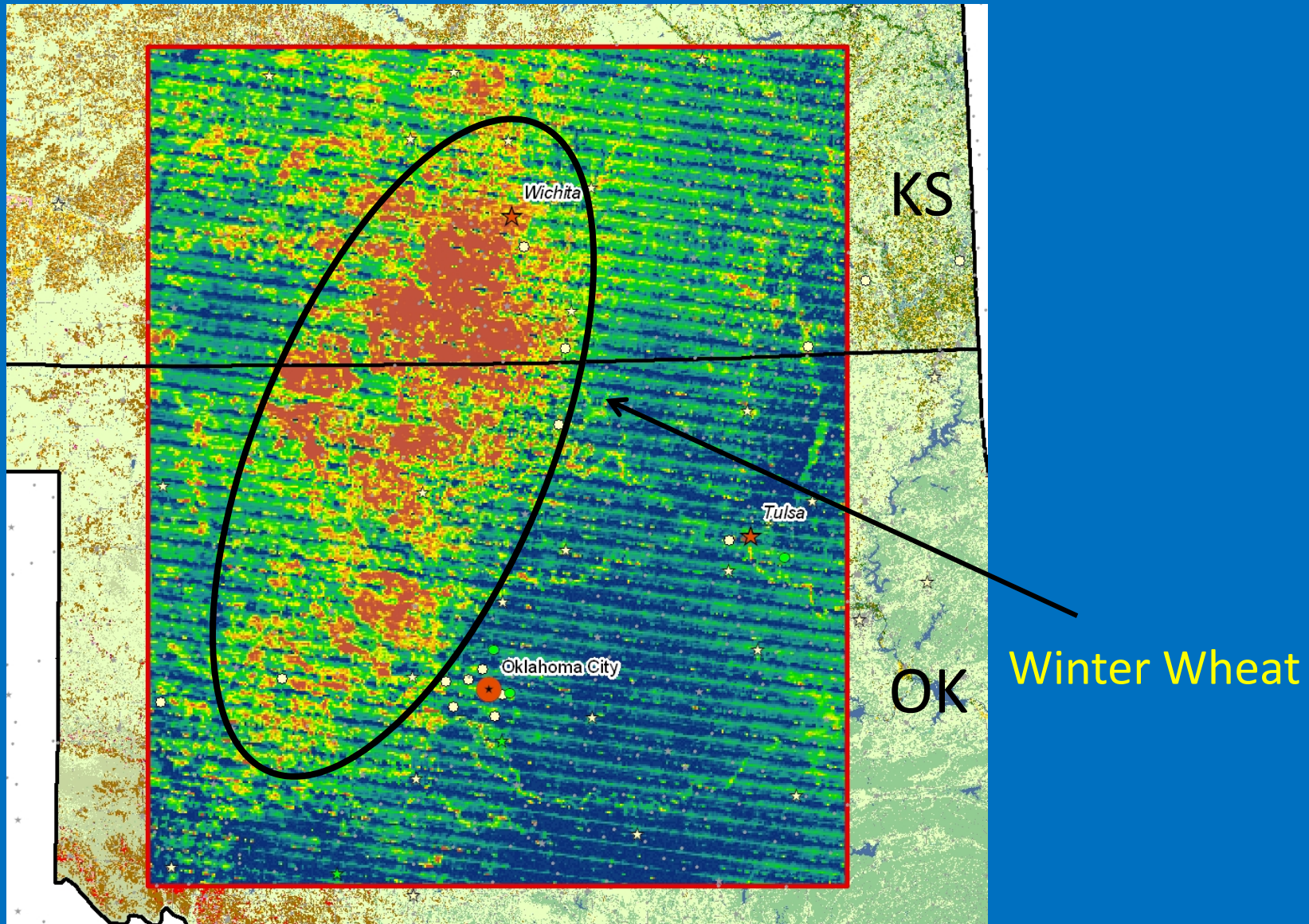
Systematic TIR calibration errors.

Systematic atmospheric correction errors.

Long term changes in soil emissivities.

Long term changes in vegetation canopy densities.

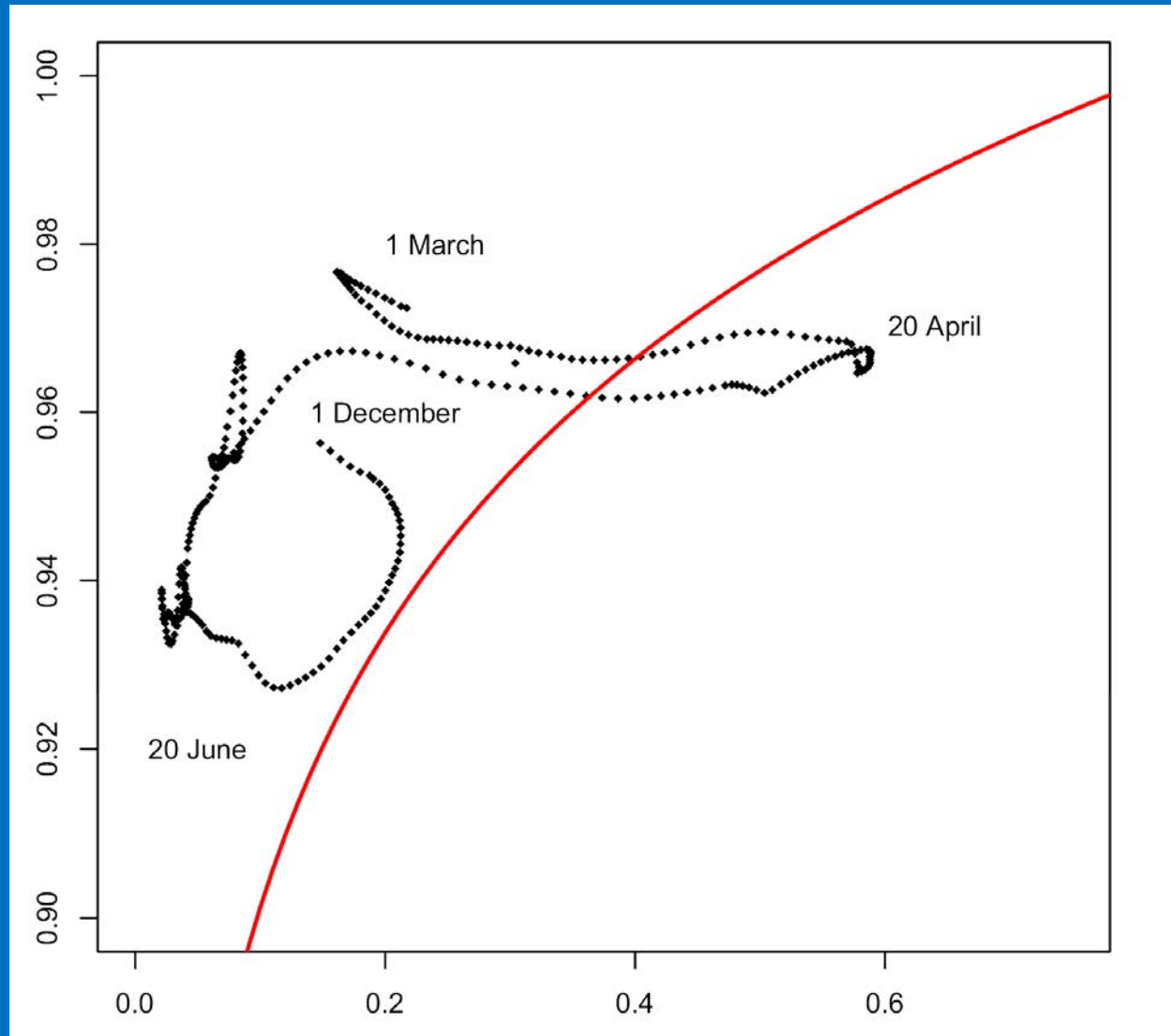
MODIS Emissivities (Band 29) SGP September 2007



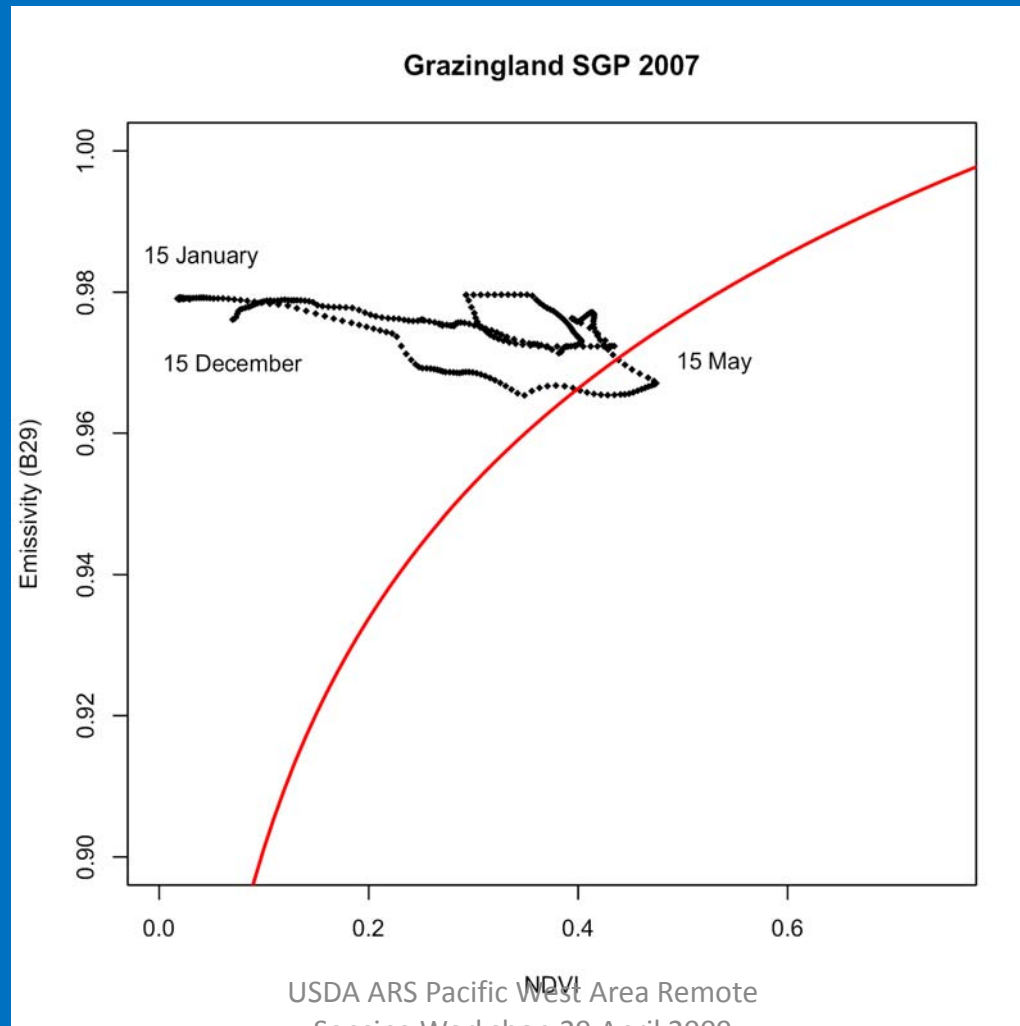
Temporal Emissivity vs. Vegetation Index

Winter Wheat in Southern Great Plains 2007

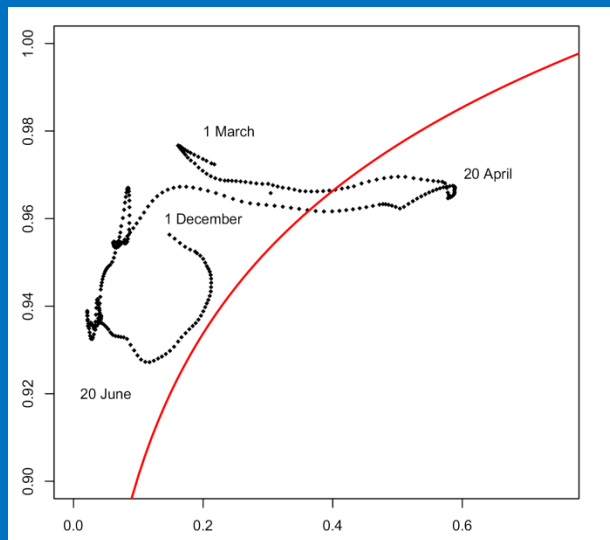
Emissivity (Band 29)



Some Agricultural Regions Show Negligible Seasonal Change in Emissivity

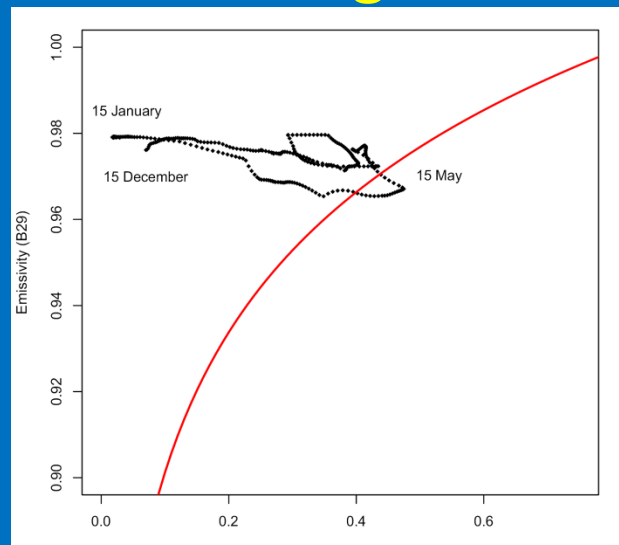


Winter Wheat

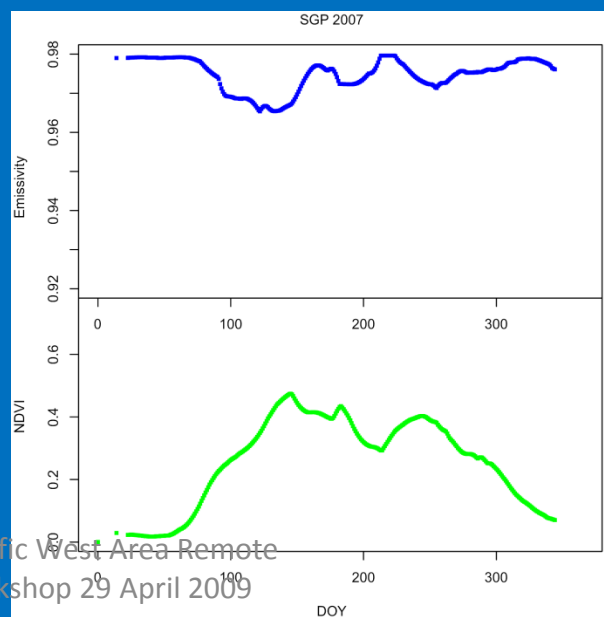
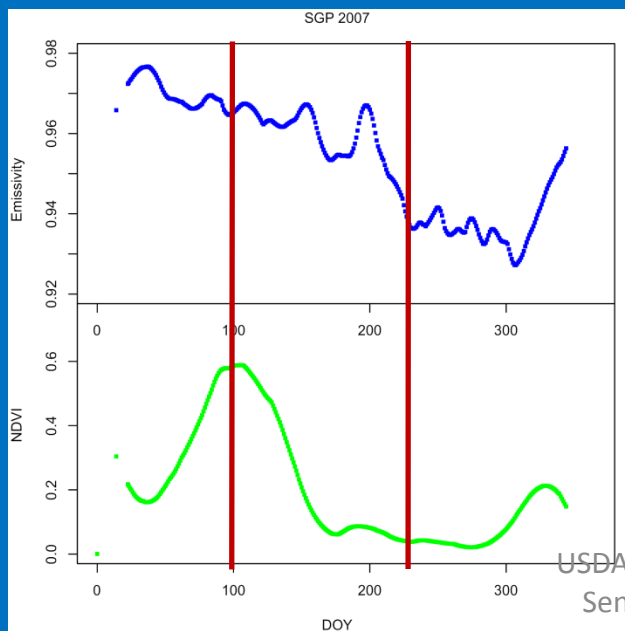


NDVI

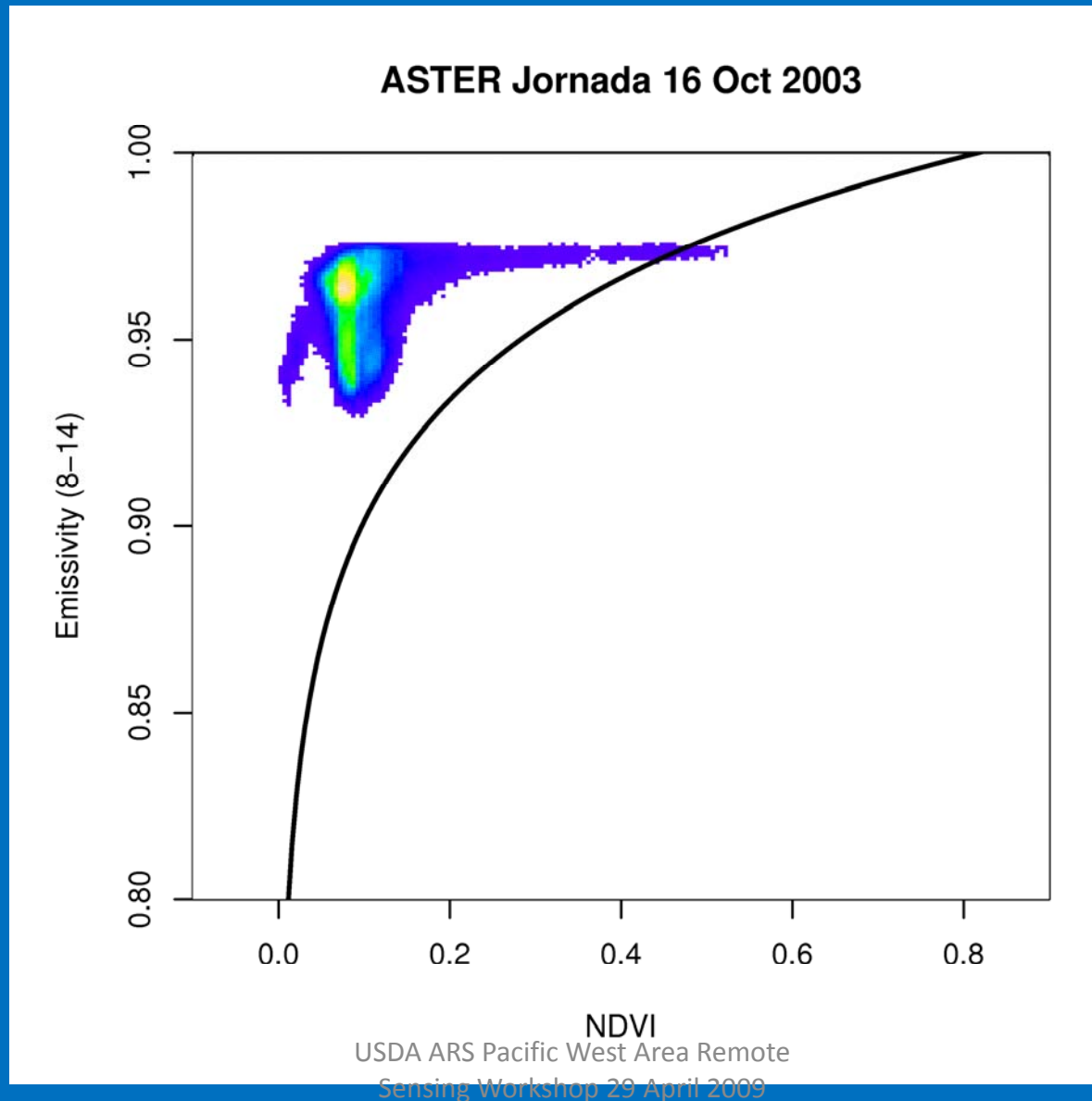
Grazingland



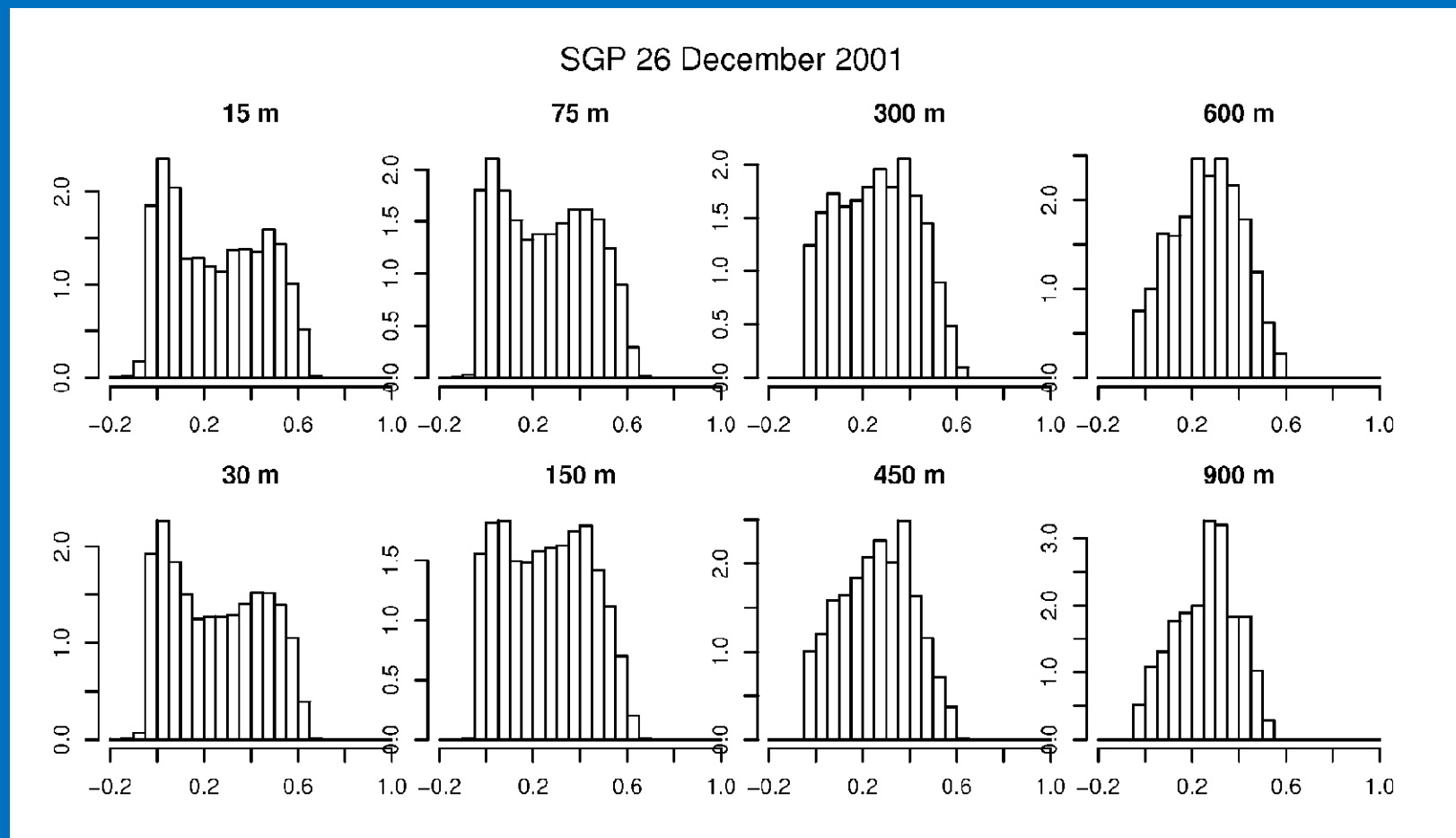
NDVI



Broadband Emissivity vs. NDVI



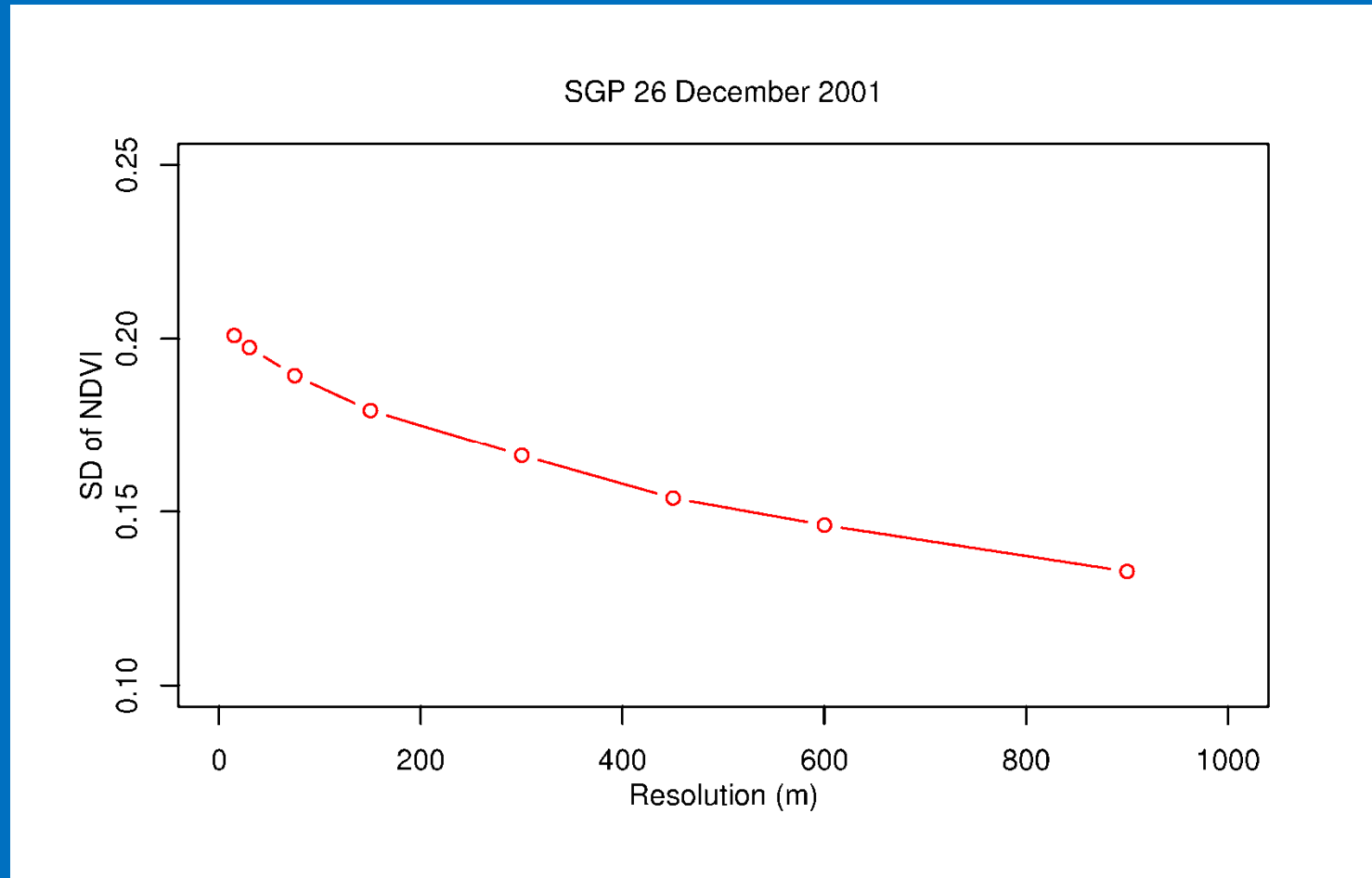
Effect of Spatial Resolution on NDVI



Conclusions

- Temporal changes in Land Surface Emissivity occur at daily, seasonal, & inter-annual time scales.
 - Depends on vegetation type & background soil.
- The changes reflect change in vegetation canopy & soil moisture.
- NDVI cannot monitor non-green fraction, thus emissivity data are complementary observations.
- Emissivity changes impact ET estimation:
 - Land Surface Temperature
 - Land Cover Type
 - Stage of Growth

NDVI: Information Loss with Resolution



ASTER & MODIS Thermal Band Responses

